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Design of a serious game in training non-clinical skills for professionals in health care area

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Abstract— **Most educational games and training applications for health care professionals have been developed as simulation tools dedicated to the teaching of medical knowledge in a particular area. Non-clinical skills such as communication skills or knowledge about e-Health are insufficiently focused by such tools. A serious game with consistent educational objectives offers to the learner many possibilities to acquire multiple competences in a fun and engaging learning process. This paper presents a serious game composed with extensible educational modules that concentrate on providing high-quality health care knowledge. It is designed to respect the balance between serious and fun in both educational and game elements. The proposed architecture allows the learning objective to be clearly defined and facilitate the collaborations of actors involved in the development. A prototype of the communication skills module is presented as an example of a module design.**

Keywords—serious game, educational game, game design, medical interview, electronic health record, e-Health

I. INTRODUCTION

The main objectives of the training and education of professionals are to build or consolidate a diverse set of skills. As a new educational tool, serious games have been used in the health care area for various advantages such as immersive and fun-learning, risk-free, and motivation-driven engagement. These serious games can be classified into three categories according to their purposes: serious games for rehabilitation, serious games for education and training of professionals, and serious games for health prevention and education [1, 2]. Most of the serious games dedicated to the education of professionals focus on the training for clinical skills in a particular area, by using a simulation-based approach. Representatives of such products are for example "Dental Implant Training Simulation" for training on dental implant practice, "Pulse!" for training clinical skills in diagnostic in an immersive virtual learning space, or "Play&Cure" for training students of 4th year medical with procedures of medical differential diagnosis [2]. Few research works, however, have been to date devoted to establishing good relationship between patients and e-Health practitioners. Moreover, serious games face some obstacles in the design process [3]. Most serious games have been developed without a proper design theory and have neglected integration of two key elements: educational objective and gameplay [4].

Doctor-patient communication is a major component of the process of health care [5]. As mentioned in studies in [6, 7] and observations by experienced GPs (General Practitioners), it is believed that good communication skills with patients are required to build a therapeutic doctor-patient relationship that plays a very important role in medical practice. Effective doctor-patient communication is essential to the delivery of high-quality health care, which enables the doctors to detect problems earlier, prevent medical crises and expensive interventions, and provide better support to their patients. As a result we consider this skill as a prerequisite skill for medical school students before starting their medical practice.

Another area non-directly related to clinical skills that we are interested in is education and information in e-health for general practitioners. Services and systems proposed by e-health including EHR(Electronic health records), e-prescribing, and Healthcare Information Systems, would allow the health care provider to be better informed, and facilitate remote medical collaboration and resource management, which helps to deliver higher quality care [8, 9].

In this context, we decided to develop a serious game to train medical students and GPs non-clinical in skills aiming at providing higher quality health care. By now the game prototype focuses on two main fields: the communication skills in the medical interview in different kinds of situations, and the use of state of the art technologies from the e-health environment, such as electronic health records.

In this paper we present the design of our game that explains the balance between educational objectives and gameplay. The game is designed by a composition of several learning modules and a chaining module. Learning objectives are extensible and the storyline can motivate users while keeping all the learning objectives consistent. The proposed architecture of the system is divided into three layers that help facilitating collaboration among diverse project teams. We detail the design and gameplay in Section 2. We have developed a prototype of the communication skills module in order to test our design method (Section 3). We conclude by summarizing the design proposed by the paper and discussing our future work.

II. METHODS

A. Educational Objectives and Needs Assessment

Our game is created to meet educational needs. The target audience includes students in medical schools attending a

required internship in General Medicine and GPs in vocational training sessions.

1) E-Health

Over the past decade, governments in most European countries have tried to develop and promote three e-Health core themes:

- Electronic health records, as a collection of electronic health information which allows the patient's data to be accessible by all actors in the health system chain, for health information exchange, sharing, tracking, etc.
- E-Prescribing to record an electronic form of medical prescription in EHR, as well as automated ordering and distributions of drugs between health care providers.
- Telemedicine, to provide long-distance clinical health care and remote-monitoring.

The success of e-health technologies depends not only on an efficient technical support and infrastructure, but also on the motivations of professionals to use these technologies and to integrate them in their everyday practices. Our game tries to presents an overview of what can be done with new e-health technologies and how it can facilitate both the patient's and doctor's life, as well as information on privacy and security of these technologies [10].

2) Communication skills

The main purpose of a patient coming for a medical visit with a GP is generally medical reasons, but psychological aspects are also of main importance. The patient wants to be treated with respect and receive clear information about his problem and disease, including the treatment method and its consequences. The establishment of a long-term trusting relationship between the patient and the GP is essential to achieve the best outcome in improvement of the patient's health, and get patient satisfaction. However studies on doctor-patient communication have demonstrated that doctors tend to overestimate their abilities in communication [11-13]. Patient surveys have consistently shown that they want better communication with their doctors [14].

B. Learning Modules and chaining module

There are two types of goals in a serious game: one is based on educational objectives and the other on game goals [15]. We have considered these two objectives all along the design phase to balance both learning and fun.

We chose to develop an adventure game, where the player takes on the role of a doctor who just graduates from medical school and steps into his career as a GP. Non-player Characters (NPC) are automatically controlled by game scenario engine and can be modified as required. Main NPCs include patients who come for a medical consultation, a secretary that helps to arrange the meeting schedule, and other doctors who provide new challenges when they are available to the player. Virtual patient profiles are characterized by attributes that reflex different traits like mood of the day, cultural background and so on.

At the beginning of the game, the player will start his first medical interview with a virtual patient. In this module a dialog-based system simulates the processes of the medical interview. The game interface allows the player to choose his strategy of communication during the meeting from a set of possible actions defined during the design phase.

It is in this session that communication skill training module is introduced for the first time. The player can improve this skill by exploring different scenarios defined with many types of the virtual patients. When the player has completed a challenge in reaching certain score, more difficult challenges are available. One of them for example, is to manage a triadic relationship. In this challenge, the player is informed of the arrival of a new NPC: the intern who comes to learn how to conduct a medical consultation. In this configuration, the player has to manage two persons during the medial interview: his patient and the intern who is both an observer and an actor of the interview. When the player succeeds, he gets a reward medal. The system of reward will be described in the following section.

If the player passes all the challenges of this module, he should be very familiar with the medical interview process, have learned communication skills, and have learned to manage different kinds of patients. In this case, e-health learning module is introduced.

This module presents information about Electronic Health Records. Players must read the detail information introducing what these records are for, how to use them, and how to add data. The whole process is just like a newbie guide for a new system utilization. After completion of basic manipulations on EHR, the player can use this system in his consultation sessions. For example if the patient already has such a record, the player can consult it to get some information about the patient history and add some data during or at the end of the interview. If the patient doesn't have one, the player can proposes to open a new record and should be able to explain to his patient why it would be a good thing to do.

Each learning module contains a different learning purpose, and the development on them is independent. Beginning with the first learning module, player can unblock a new educational module by achieving defined objectives. The chaining module contains reasonable scenario to form a storyline which integrate the modules together. More other learning modules can be introduced to the player when these "newly occurred events".

This design method makes the educational objectives in the game extensible. Meanwhile the learning process is presented as a consistent interactive story. Learning modules can be added, deleted or modified by a customization interface. Players can improve their skills through a number of game challenges and explorer new areas when some goals are achieved.

C. Gameplay

The gameplay component is the most important element in entertainment games. In the case of serious game, a good gameplay should ensure that the engagement, fun and game

immersion is well integrated with the learning goals. In other words, the act of playing should provide the player with the targeted knowledge, or with a specific pedagogic message. In this section, we present our design choices that make our game motivating and fun.

1) Storyline and game goals

Educational modules are introduced to the player by following an engaging storyline where secondary objectives are interleaved with the main goal of providing care to several patients. One of these secondary objectives is for example to discover a patient secret. This discovery can be realized by obtaining a sufficient amount of information about the patient, either by asking some general questions during the interview process (communication skills module), gaining access to historical records (electronic health records module), or getting some advice from a colleague (telemedicine modules). The access to more modules is conditioned by the realization of some achievements but also by the occurrence of some events. For example the player character can be called by a colleague just returning from a conference about e-Health, and this event will open an access to the telemedicine module. Following the module will unlock some functionality in the game like the possibility to schedule distant patients for next consultations.

2) Patient diversity

The game provides several types of patient and each type will have to be correctly handled by the player in mobilizing the correct communication skills. Some patients can be aggressive, other excessively shy. Some are really ill when others just think they are. Some have made a lot of research on the Internet before coming to the interview, others might be members of patient organizations. All these diversity allows keeping interest in the repetition of consultation during the game.

3) Reward system

When game goal is reached player will get "rewarded". Main elements in the reward system are:

- Score based on statistics: number of patients followed by the player, number of meeting conducted, number of modules unlocked…
- Development of the player avatar. As in role playing game, the player character will gain points in some characteristics while playing: charisma, reputation, experience… and will have the possibilities to improve its office and its career (medical and computer equipment, hierarchy position, office localization etc.).
- Medals (trophy). Player will get medals when he reaches certain goals. For example, he will be attributed a medal called "TIC Pioneer" when he completes the learning module for Electronic Medical Records.

4) Feedback

Performance feedback is mainly provided by the reactions of patients. These reactions are illustrated by a stress indicator during the consultation process. This stress indicator can take different forms, from a simple visual filler bar to changes in patient facial expressions and voices. The stress value is not a simple thing to manage for the player. Sometimes, player actions will stress the patient. Some are necessary, like disturbing questions about his private life while others are just the results of an incorrect move in the game. If the patient stress is too high, the information obtained from the patient will not be reliable. This is where the communication skills of players come into play. They can choose to ask "general questions" to the patient, unrelated to patient health, so as to lower patient stress. But not too much, because time is also important and other patients are waiting. This balance that the player must find to correctly handle the patient stress is one of the key elements of the game.

D. General System Architecture

To facilitate the development and test within different teams, each system module is divided into 3 layers: representation, scenarios and knowledge contents (Fig. 2).

The independence of the representation layer enables a total freedom of choices for the game presentation. For example the interface of the game can be a first-person view in a 3D environment or a simpler graphic version where just the patient face is shown. Interactions can also vary. Voices and animation can be added without changing the other layers.

The knowledge contents are defined by domain experts such as physicians, professors of medicine, psychologists etc. For each educational module this layer is defined separately according to the training content. For example, in the communication skills module, this knowledge takes the form of several rules. The rules determine which actions have a benefit or negative effect during the medical consultation, as well as the influence of each type of action on the patient stress. In the electronic health records module, the knowledge takes the form of tutorials that explains the role, composition and use cases of these records, with juridical and security information.

The scenario layer contains a list of challenges for the module. This layer is defined by game experts, AI designers, developers etc. Challenges should be able to integrate educational objectives into the play. For example, in the communication skills module, the scenario layer models different types of patients with their own traits, history and pathology (Fig. 1).

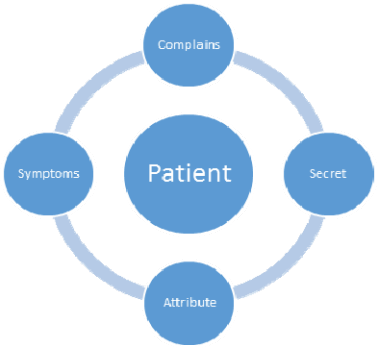

Fig. 1. Virtual patient model

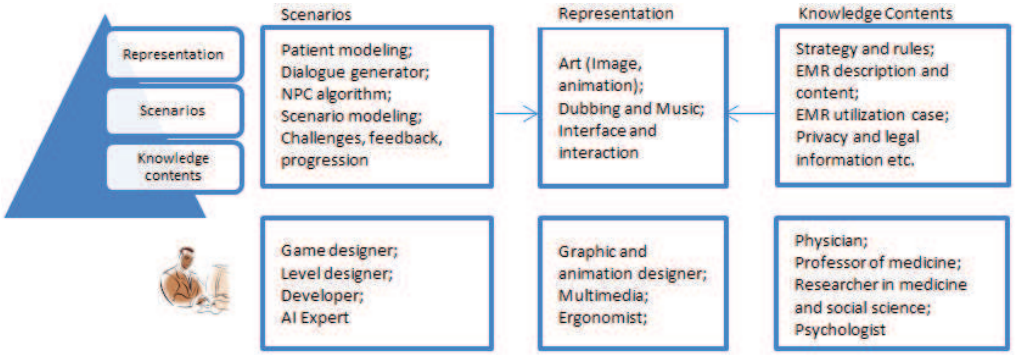

Fig. 2. System architecture

III. Prototype of Communication Skills Module

A prototype of the communication skills module is under development. The view layer takes the form of a web application (HTML5/javascript) accessing the knowledge content and scenario layers by a restful web service.

A. Medical consultation process modeling

According to [16], we have identified the medical consultation process between a GP and a patient as four phases:

- P1 Initialization of session: Prepare the session, greet patient and introduce self, identify the reason(s) for the consultation.
- P2 Information gathering with or without physical examinations: in this phase the physician should explore patient's problems to identify patient's ideas, concerns, expectations and troubles. Invites the patient to some physical examinations if necessary.
- P3 Explanation and planning: in this phase the physician should provide a diagnostic, a treatment plan and explanations to the patient. He should ensure that the patient understand and will recall the information, and that the patient is adhering to treatment.
- P4 End of session: Summarize the session, fix appointment for next visit, say goodbye.

We decompose each phase in several mandatory steps. The player can choose among several main actions such as perform a physical examination and give a summary of current information. The advancement of game follows the mandatory steps. The game interface will propose sentences in several language styles as pre-defined in the knowledge content layer. If the player chooses to take this action, game will progress forward to the next step. When player reaches the last mandatory step of the phase, game will move on to the next phase if the current phase is not the last. Actions provided in the game allow the player to practice the communication skills in [17] through these 4 phases. An example of the interface of this module is shown in Fig. 3.

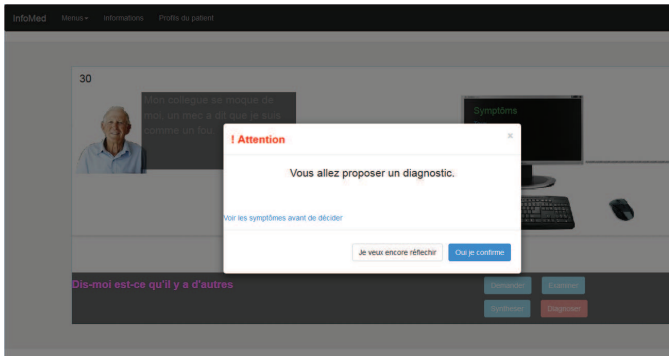

Fig. 3. Interface of prototype "*aller pour diagnostiquer*"

B. Scenario / Mechanism

The scenario module defines two elements. First, it models a virtual patient with some key characteristics. These characteristics are chosen among those already defined in the knowledge content layer (rules and strategies). Then it defines all the possible actions and interactions for the player in each phase of the medical consultation process. These models are built by experts from different disciplines, mainly health care and game design.

Fig. 4 shows how the game engine is working. Player's actions affect the status of the virtual patient according to the patient's profile and the rules defined previously in the Knowledge Content module. Changes in patient status cause

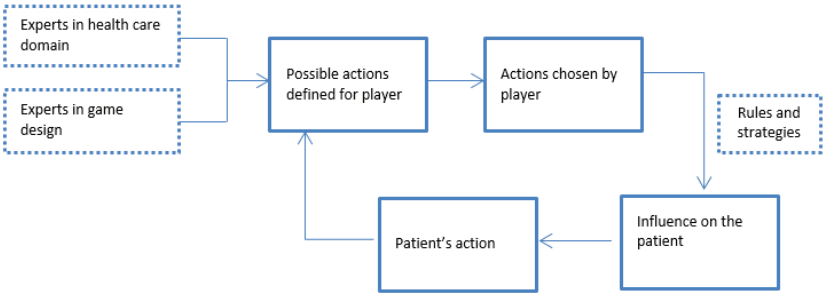

Fig. 4. Game engine of the communication skills module

changes in his behavior, while new possible actions are provided to the player.

Player's actions are recorded, especially when he makes a wrong choice. At the end of each phase of the consultation, a screen is shown that summarized these actions and identifies the bad choices with the move that should have been played instead. This screen is a feedback element that can be access by the trainer or his supervisor. It helps to illustrate the acquired communication skills. In addition, the proposed synthesis information helps the player to view all the information gained from the patient and serves as a guide to continue the game in other directions.

C. *Integration of learning objectives examples*

- The player learns about the medical consultation process as the game moves forward phase by phase, and inside each phase, step by step.
- The interface of the game offers the player the possibility of periodic summaries to the patient, recommended action to properly conduct a medical consultation. Player can click at any time on a "synthesis" button during the phase of information gathering. Failures on using this function wisely are sanctioned in the score, e.g. fact of abuse.
- From different type of sentences proposed by the game the player can learn how to adapt language style according to the profile of the patient.
- Other non-medical related information can be acquired by asking General Questions. This functionality provides the possibility to demonstrate empathy, concern and humanism, and aims in establishing a long-term relationship with the patient. This relationship is critical in the medical consultation so that both parties get information clearly, understand the issues and can take shared decisions.

IV. RELATED WORK

There are lots of serious games in the health care area, but few of them are developed for the purpose of education or training for health care professionals. Some related products or projects are presented as follows:

1) Pulse! Virtual Clinical Learning Lab for Health Care Training

Pulse! is an immersive virtual learning space for training health care professionals in clinical skills without the risk of harming patients. Players work in a virtual hospital where they respond to emergency situations, diagnose, and treat patients as they would in the real world. This game was developed in part by the Texas A&M University, Corpus-Christi.

2) HumanSim

HumanSim is a simulation game based on GO platform that provides medical education and training in various areas [18]. GO is a single/multi-player immersive training and education platform based on Epic Games' Unreal Engine 3. GO consists of a series of ActiveX/Netscape plug-ins that contain the Unreal Engine connected to backend computer server infrastructure. The game facilitates self-paced learning and team training which allows accelerating learning, increasing user proficiency, and reducing training costs.

3) 3D VOR (3d virtual operating room)

3D VOR is a platform online of 3D simulation to inform and train professionals in an operation room to manager the risk and prevention of serious adverse events.

Most of them are simulation games that can be seen rather as a simulator. These games allow the player to experience in a realistic virtual environment, which is a great advantage in learning process. However the fun objective is not considered in these games. Inspecting these previous works reminds us to pay more attention to this sphere in the design phase.

As described in [19], the design patterns of good serious game require to pay more attention to the gameplay. For that, our work and its three layers architecture has been inspired by the concept of "play, meaning, reality" described in [3].

V. CONCLUSIONS AND FUTURE WORK

We have described the design of a serious game for the training and education of professionals in the health care area. The game is designed as a set of modules linked by a general story line. Its scenario delivers an adventure in the world of e-health where the player will discover how to make an efficient use of new technologies to improve his professional activities. The game is not yet complete and this article has focused on the description of the communicational skills module to show with more details how the design method can be applied on a concrete case.

Future work includes the evaluation of the current implementation. It will be realized by students of the

University of Medicine of Toulouse (France), just before they start their internship in the general practitioner specialty. This feedback will allow some adjustments in the game and the development of other modules.

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